

**Biological Evaluation
Non-native Woody Invasive Species (NNWIS)
Hillside Woodland
Fort Necessity National Battlefield
Fayette County, Pennsylvania**



Prepared by:

Donna M. Foster
Landscape Architect

Heather Smith
Biological Science Technician

and

Richard M. Turcotte, PhD
Forest Health Group Leader

USDA Forest Service
Northeastern Area State and Private Forestry
Forest Health Group
180 Canfield Street
Morgantown, WV 26505

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Table of Contents	
Abstract:	3
Purpose and Need:	Error! Bookmark not defined.
Project Location:.....	4
Hydrology	4
Project Objectives:	5
Project Methods:.....	5
Inventory Plots:	5
Data analysis.....	6
Results:	6
Species of Note.....	9
Discussion	9
Management Alternatives.....	10
Alternatives	10
No Action	10
Mechanical Control Only	10
Chemical Control Only.....	11
Integrated Vegetation Management.....	12
References:.....	13
Appendix.....	15
Appendix 1. Non-native Woody Invasive Species Datasheet:.....	15
Appendix 2. Herbicide Treatment Volume Estimates per Extrapolated Data:.....	16
Addendum 3: Botanical List of Native Plant Species.....	17
Addendum 4: Pesticide Safety.....	18

Abstract:

During 2017, personnel from the USDA, Northeastern Area State and Private Forestry Field Office conducted a survey of non-native invasive species found growing in the Hillside Woodland at Fort Necessity National Battlefield. The purpose of the survey was to assess the extent of non-native woody invasive plant species present. At this time the US Forest service recommended that a Biological Evaluation be developed that would assess the native community, determine the extent of the infestation and recommend control options targeted at improving native plant diversity, habitat and the potential for regeneration of oak species in the stand in a manner that is consistent with the NPS mission.

Purpose and Need:

The request for this work was received MaryEllen Snyder, Management Assistant, National Park Service/Western Pennsylvania Parks, Fort Necessity National Battlefield Park Service.

This work aligns with:

- The Great Meadows Cultural Landscape Report (1998) that documents scientific research, identifies four priority areas within the Great Meadows, and recommends management alternatives for each
- The Implementation Options for the Various Components of the Great Meadows Cultural Landscape Rehabilitation Project (Ranson 2001) that recommends treatment for the four priority areas
- The Southern Laurel Highlands Plant and Pest Management Partnership (SLHPPMP) Invasive Plant Control Recommendations for the Great Meadows Restoration Project (2015)
- The Great Meadows Restoration (2016)

The introduction and naturalization of non-native invasive plant species into native plant communities has emerged as a problem of primary importance for natural areas management. Both deliberate and intentional non-native introductions have long been associated with human movement, but the rate of artificial introductions has increased dramatically in the wake of European colonization and the ease of transoceanic transport over the past two centuries (Mack et al. 2000). Non-native invasive plants can spread quickly and aggressively in the absence of co-adapted herbivores, pests, and parasites (Blossey and Notzold 1995). Plants which are far from dominant in their natural communities can overwhelm the competition in their new homes, altering community structure and change nutrient cycling, slowing succession, and interfering with the fire regime in fire-adapted systems (Tu 2003, Gordon 1998). Agricultural, successional and fragmented habitats are significantly more vulnerable to invasion than intact later successional types (Myser and Pickett 1990, Cadenasso and Pickett 2001, Robertson et al. 1994, Symstad 2000). Because of this, invasive plant control is of much

greater importance in smaller areas, with high perimeter (edge) to area ratios, large areas of successional habitat, or highly heterogeneous vegetative communities. The Hillside Woodland at Fort Necessity National Battlefield is a highly vulnerable vegetative community due to human disturbance, its proximity to development, and the fact that dense shade in the understory.

Project Location:

Fort Necessity National Battlefield (FONE) is 903 acres in size. The Hillside Woodland site is located below the Historic Tavern and to the north of the Great Meadows site. It is located in Southwestern Pennsylvania off US Route 40 about 10 miles southeast of Uniontown, PA (lat. 39°48'50.9"N, long 79°35'10.35"N). The site lies in the Allegheny Mountains of the Appalachian Plateau, an area also known as the Southern Laurel Highlands. Elevations in the park range from 1755 to 2329 feet. The Hillside Woodland is a small wooded site 5.89 acres in size located northeast of the historic fort at the park (Figure 1).

Project Description:

The Hillside Woodland is considered an eastern mixed deciduous forest (Figure 2). The average tree age is approximately 80 years. A number of large mature white oaks (*Quercus alba*) are present. Tree species are primarily red maple (*Acer rubrum*), yellow poplar (*Liriodendron tulipifera*), oak (*Quercus* spp.), ash (*Fraxinus* spp.), and hickory (*Carya* spp.). Yellow poplars dominate the understory and are beginning to prevail in the canopy. Multiflora rose (*Rosa multiflora*), barberry (*Berberis japonica*), bush honeysuckle (*Lonicera morrowii*) and winged euonymus (*Euonymus alatus*) (exotic invasives) are dominant in the understory.

Hydrology

The Hillside Woodland site slopes gently to the south at a grade of about 6%. Surface water flow from an 18" pipe that drains the Historic Tavern site and parking lot flows into the hillside woodland per a manmade culvert. The flow from this drainage pipe transects the woodland in a north/south direction and appears to follow a naturally occurring ravine. It feeds a small



Figure 1. Fort Necessity National Battlefield site map.

Fort Necessity National Battlefield Property Boundary
Invasive Plant Biological Evaluation
Invasive Plant Control Prescription Areas
November 16, 2016



Figure 2. Hillside Woodland looking southwest toward the Great Meadow and Fort Necessity.

wetland in the Memorial Tree Planting area and then surface flows into Great Meadow Run Creek.

Project Objectives:

The objectives of this evaluation were to 1) inventory native and non-native woody plant species, 2) quantify NNWIS cover, height, number of stems and stem diameter per acre, 3) propose NNWIS management options, and 4) provide NNWIS with herbicide treatment recommendations based on findings.

Project Methods:

On April 12, 2017 Donna Foster and Heather Smith, U.S. Forest Service assessed the cover of NNWIS in the woodlot using a methodology that established three 10' feet wide x 100' long permanent plots in the woodlot to inventory, quantify cover, height and stem diameter of NNWIS.

ArcMap was used to develop a site map and document the location of the plots (Figure 3) using electronic data provided by NPS and the US Forest Service. The site map was used to delineate the site boundaries, examine the hydrology, calculate acreage, and better understand the extent of tree cover and open areas in the Hillside Woodland. Digital files were brought into ArcMap using the ESRI GIS Online application at the map projection of NAD 1983 UTM 17.

Inventory Plots:

A simple methodology was developed to calculate invasive plant cover, height, number of stems and stem diameter. A "NNWIS Data Sheet" was developed for field data collection purposes (Appendix 1).

Cover is defined as the amount of ground covered by the vertical projection of the plant vegetation (Elizinga et al. 2009). Cover measurements were taken in two dimensions with the first taken at the widest extent of the living portion of the crown and the other at a right angle to the first. The number of stems, stem diameter and height class data was collected for all NNWIS in the plot inventory area. Basal stem diameter was measured at base of the stem just above the root collar to the nearest tenth of an inch. Height was measured using a graduated pole. Height is defined as the distance from the root crown to the tallest part of the living part of the plant (Table 1).

Three plots were selected that best represent NNWIS invasion on the site (e.g. edge and interior). Plot dimensions 10' x 100' were located on north/south axis using a compass. The total plot area represents 1.2% of woodlot sampled. Centerline beginning and end point of each

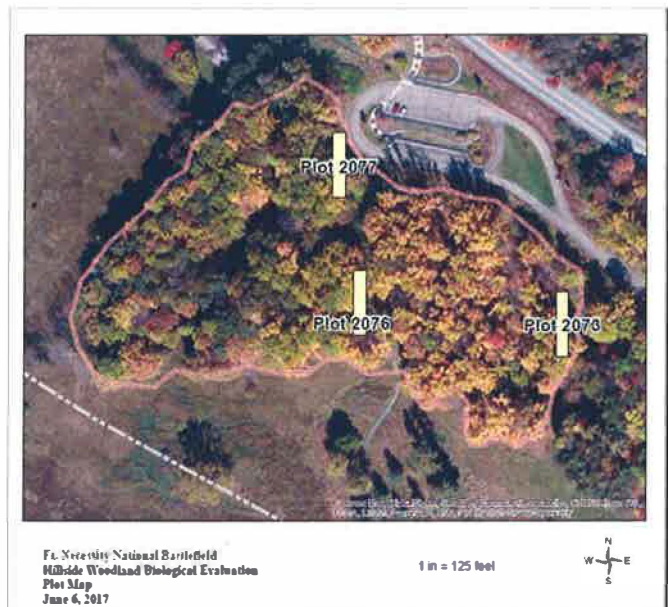


Figure 3. Location of sample plots in the Hillside Woodland.

plot was documented with a permanent metal field tag and the GPS coordinates. Only plants rooted within the plot were counted and measured for stem number and diameter. Any boundary stems with more than half their diameter in the plot were included. Cover and height measurements were made on part of the crown occurring within the plot.

Survey equipment required for making measurements of cover, height, number of stems and stem diameter included: a GPS unit, compass, 50 feet tape measure and 100 feet tape measure, two 5-feet long measuring sticks to determine width and height of NNWIS, paper data sheets, a clipboard, camera, personal protective equipment and permanent metal marking tags.

Table 1. Stem diameter and height classes of NNIWS in each plot.

Variable	Size Classes			
Stem Diameter (inches)	0 - 0.49"	0.5" - 9.9"	1.0" - 1.49"	1.5" - 2.0"
Height Class (inches and feet)	0 -0.9"	1.0' – 2.9'	3.0' – 4.9'	5.0' – 7'+

Data Analysis

Cover was calculated using a simple square area formula ($W \times L$). Cover, height, and stem diameter data for each plot was calculated. Cover and stem diameter were and then extrapolated to determine an estimate of NNIWS cover and basal stem diameter over the entire site.

Results:

Non-Native Woody Invasive species dominate 78% of the understory cover (4.59 acres of the 5.89 acre site) in the Wooded Hillside (Table 2). Table 3 data shows that the dominance of NNWIS in the understory changes throughout the site with Morrow's honeysuckle most dominant at 33% cover, followed by Multiflora rose at 23% cover, and winged burning bush at 15% cover. Past mechanical control of the winged euonymus appears to have contributed to the decrease of this NNWIS in cover. Interestingly the mechanical control of the winged euonymus and its subsequent resprouting, has contributed to it being the most prevalent NNWIS in the 0"-0.49" stem diameter class, leading to the conclusion that the mechanical control of winged euonymus has contributed to the dominance/release of multiflora rose in the herbaceous cover class.

Table 2: Non-native Woody Invasive species by Percent Cover per Plot (1,000 sq. ft.)

PLOT #2077	Cover	PLOT #2076	Cover	PLOT #2073	Cover
<i>Berberis thunbergii</i>	0.40%	<i>Berberis thunbergii</i>	0.10%	<i>Berberis thunbergii</i>	0.50%
<i>Euonymus alatus</i>	28.80%	<i>Euonymus alatus</i>	14.40%	<i>Euonymus alatus</i>	0
<i>Forsythia suspensa</i>	10.00%	<i>Forsythia suspensa</i>	0	<i>Forsythia suspensa</i>	0
<i>Lonicera japonica</i>	1.20%	<i>Lonicera japonica</i>	0	<i>Lonicera japonica</i>	10.40%
<i>Lonicera morrowii</i>	14.20%	<i>Lonicera morrowii</i>	58.90%	<i>Lonicera morrowii</i>	26.80%
<i>Rosa multiflora</i>	19.50%	<i>Rosa multiflora</i>	12.60%	<i>Rosa multiflora</i>	37.30%
Other Species/Open	25.90%	Other Species/Open	14.20%	Other Species/Open	25.00%

Finding: Plot #2073 is dominated by multiflora rose, Plot #2076 is dominated by Morrow's honeysuckle and Plot #2077 is dominated by winged euonymus.

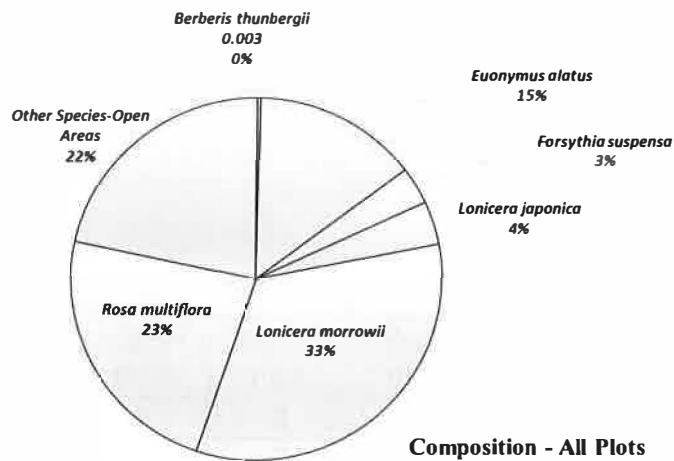


Figure 4: Composition - All Plots

Findings: Across all plots, Morrow's honeysuckle cover is most dominant (33% cover) followed by Multiflora rose (23% cover) and then winged euonymus (15% cover). Overall, 78% of the understory is invaded by NNWIS.

NNWIS	0"-4.9"	.5"-.9"	1"-1.4"	1.5"-2"	>2"
<i>Lonicera japonica</i>	2	0	0	0	0
<i>Berberis thunbergii</i>	12	0	0	0	0
<i>Forsythia suspensa</i>	20	0	5	1	0
<i>Rosa multiflora</i>	202	31	1	0	0

<i>Euonymus alatus</i>	228	4	1	0	3
<i>Lonicera morrowii</i>	233	9	0	0	0
	697	44	7	1	3

Table 2: All Plots - Stem Diameter Class

Findings: Stem diameter 0" to 0.5" is most prevalent across all plots. Data shows that winged euonymus has achieved the greatest stem diameter (>2") of all species in the Hillside Woodland.

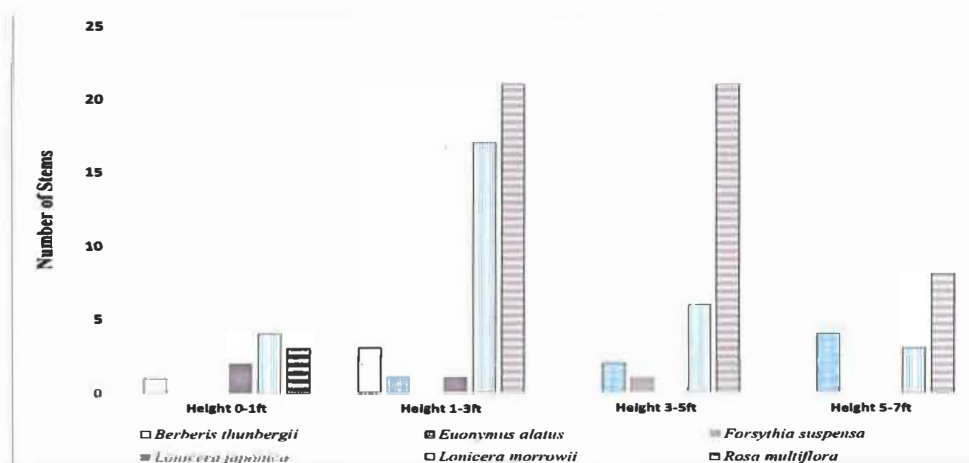


Figure 5: All Plots – Height Class by Number of Stems

NNWIS Stems	Height 0-1ft	Height 1-3ft	Height 3-5ft	Height 5-7ft
<i>Berberis thunbergii</i>	1	3	0	0
<i>Euonymus alatus</i>	0	1	2	4
<i>Forsythia suspensa</i>	0	0	1	0
<i>Lonicera japonica</i>	2	1	0	0
<i>Lonicera morrowii</i>	4	17	6	3
<i>Rosa multiflora</i>	3	21	21	8

Table 3: All Plots - Height Class

Findings: Multiflora rose dominates all height classes 1' through 7', except for the 0-1 feet height class which is dominated by Morrow's honeysuckle.

Species of Note

US Forest Service staff identified a native orchid called Brown wide lip orchid, (*Liparis liliifolia*) in the Hillside Woodland in summer of 2016. This orchid was not documented on any prior NPS plant inventory list.



Figure 6. Brown wide lip orchid (*Liparis liliifolia*) discovered during the assessment of the Hillside Woodland.

Discussion

Using this simple inventory methodology, natural resource managers can describe and monitor structural diversity of NNIWS.

The composition of dominant species in the Hillside Woodland has changed from primarily an oak-dominated forest to that of tulip poplar, red maple, and ash. The change in composition of the forests is attributed to the impact of NNWIS, deer browse and the exotic emerald ash borer (EAB) that is killing all the ash trees in the woodlot.

NNWIS documented as being present in the woodlot include Japanese barberry, winged burning bush, weeping forsythia (*Forsythia suspensa*) Japanese honeysuckle (*Lonicera japonica*), Morrow's honeysuckle and multiflora rose. The ornamental planting of weeping forsythia most likely originated from landscaping at the Historic Tavern and is rapidly colonizing the stand from the northern edge moving southward. Forsythia seedlings can be found throughout the understory.

Japanese knotweed (*Fallopia japonica*) is established on the steep bank between the visitor parking lot of the Historic Tavern and the Hillside Woodland site and appears to be following the pattern of drainage established by the parking lot drain pipe. Because of the location of the Japanese knotweed, it has not been documented in the woodland plots.

Japanese honeysuckle will become more competitive once the larger NNWIS are removed. It should be carefully monitored, and if necessary a treatment plan should be developed specifically to prevent its dominance in the herbaceous layer of the woodland

The Hillside Woodland edge is highly degraded on all sides with little regeneration of typical native species due to the high number of NNWIS present. Previous mechanical removal of Morrow's honeysuckle is evident by the presence of a large number of cut stumps greater than 2" in stem diameter. Eastern hophornbeam (*Ostrya virginiana*) is regenerating in the southern edge of the woodland. Regeneration of oak species in the stand is prevented due to shading by

NNWIS and heavy deer browse. This dense shade from NNWIS favors regeneration of yellow poplar over oak. (Dey D. et. El. 2008). In areas along the edge of the woodlot where there is adequate light, white oak saplings have established and appear to be doing well.

Management Alternatives

Four management options are proposed to control NNWIS at the Hillside Woodland. The management options are based on the objectives of this Biological Evaluation.

1. No Action
2. Mechanical Control Only
3. Chemical Control Only
4. Integrated Pest Management (Mechanical, Biological and Chemical Control)
5. EDRR
6. Long Term Monitoring with Adaptive Management

Alternatives

1. No Action – If no action is taken to control the NNWIS in the Hillside Woodland, NNWIS will increase and continue to out compete all native plant species in the herbaceous, understory and canopy layers. Diversity and habitat quality will continue to decrease. NNWIS establishment in gaps created by Emerald Ash Borer mortality will be exacerbated. The dense shade created by the NNWIS will favor tulip poplar establishment and prevent oak seedling establishment. It is likely, at some point, tulip poplar saplings will no longer be able to compete with NNWIS and native tulip poplar establishment will also decline.
2. Mechanical Control Only – Mechanical control is labor intensive and less effective than chemical control because the total eradication of NNWIP by cutting is unlikely due to sprouting and regrowth from existing root systems and stumps. For complete control, all roots must be removed entirely. This can be achieved by using a Weed Wrench for NNWIS with stem diameters less than 1", but total elimination of root systems of larger NNWIS is highly unlikely unless the root systems are dug out by hand or with a backhoe. The disturbance created by mechanical removal of root systems and stumps exposes bare soil. This exposure provides an opportunity for invasion by other non-native woody and herbaceous species from existing seed banks and new site introductions. Mechanical control alone is best for smaller patches that can be removed by equipment or small individual plants that can be pulled up by hand (especially when in moist soil) in order to remove the roots as well. Areas would need to be re-checked to remove new plants if they arise.

Fecon Head grinding removes all woody plant material, and is particularly damaging to non-target native woody species important for future regeneration. The use of a Fecon Head should be carefully considered where restoration is a primary objective and cost of restoration is a factor. Selective mechanical removal is more labor intensive but much more cost effective if existing native plants are not destroyed during NNWIS control

activities. This can be prevented by inventorying and tagging native trees and shrubs and using the Fecon Head during dormant periods to prevent destroying native herbaceous plants via compaction of the soil and crushing.

Woody vines that are climbing up trees and saplings are easily recognized in the early spring before native plants leaf out. Vines that can be reached should be cut off at shoulder level and left hanging in the trees so they can be pulled from there when they dry out and disintegrate naturally. Vines growing horizontally along the ground can be pulled by hand in early spring and summer when the soil is moist to maximize the amount of roots pulled up.

Because NNWIS grow quickly and respond to cutting by sprouting from both the roots and cut stumps, the use of mechanical cutting is not an effective means of control unless it is done over a period of years until the NNWIS have exhausted food reserves and the regeneration of native species replace them via competition.

Chemical Control Only – Chemical control is often the most effective control strategy for controlling NNWIS if environmental impacts, timing, and life cycle are fully considered in timing applications.

Spray-Foliar Treatment 1: Species: Japanese barberry, winged euonymus, Weeping forsythia, Japanese honeysuckle, Morrow's honeysuckle and Multiflora rose less than 1" diameter stem class. Rationale for Use: A mixture of two herbicides is most effective when chemically treating a wider range of NNWIS. Rate: 1.5% of Rodeo and 2% of Garlon 3A by volume per *specific* label mixing directions. Timing: Best results occur when treated during Mid-May to Mid-September when desirable plants are identifiable to prevent spraying non-target species. Spot treatments can be done in early fall for missed plants or intermittent sprouting. Spot spray again in early spring prior to non-target leaf-out with care taken to protect early flowering spring species. Application: Foliar spray with backpack sprayer. Wet foliage completely with no dripping.

Spray-Foliar Treatment Option 2a: Species: Japanese knotweed Rationale for Use: The control target is the extensive rhizome system which is impacted most by systemic herbicides. Exhaustion through cutting/mechanical means is unlikely to exhaust its food reserves. (A. Gover 2015). Cutting is recommended in early summer to weaken the rhizomes due to spouting of new growth after cutting (Rakesh, 2016). Aqua Neat is recommended because it is an herbicide safe for use along waterways and waterbodies. Rate: 5% solution of Aqua Neat aquatic herbicide by volume (6 fluid ounces per gallon) with non-ionic surfactant per Aqua Neat label. (Penn State Quicksheet 1, Art Gover, et al. 2008). Timing: Cut to 2-3 feet height in early summer after full leaf-out. Foliar application in late summer to ensure the herbicide is translocated into the rhizome system. Spraying is effective after first frost. Application: Foliar spray with backpack sprayer. Wet foliage completely with no dripping.

Stump-Cut Treatment: Option 3: Species: Japanese barberry, Winged euonymus, Weeping forsythia, Japanese honeysuckle, Morrow's honeysuckle and Multiflora rose greater than 1" diameter stem class. Rationale for Use: A stump-cut treatment is the best method for preventing sprouting and to kill root systems. The ideal treatment method is to apply directly to a freshly cut stump. The use of a non-petroleum basal oil provides greater penetration into woody tissue. Rate: Garlon 4 Ultra at 20% by volume mixed with a non-petroleum basal oil. Application: Paint herbicide on (ideally) immediately after cutting without letting it drip down outside of cut edge of stump (possibility of damage to non-target species).

Table 4: Brand names by active ingredient by percentage. The percent active ingredient varies by brand names. To insure greatest control herbicides must be determined by active ingredient %.

Brand	Active Ingredients	Application
Aqua Neat	53.8% Isopropylamine salt of glyphosate	Foliar 5% solution by volume
Garlon 3A	44.4% Triclopyr Triethylamine salt	Foliar 2% solution by volume
Garlon 4	60.45% Triclopyr butoxyethyl ester (old)	Stem 20% solution by volume
Rodeo	53.8% Isopropylamine salt of glyphosate	Foliar 1.5% solution by volume

Integrated Vegetation Management – IVM (Suggested Option)

An integrated vegetation management system that uses mechanical control, chemical control, EDRR, and long-term monitoring is proposed as the option for the most effective control to reduce NNWIS populations in the Hillside Woodland. IVM with adaptive management actions that include volunteer mechanical removal via partners, mechanical removal via contracts and partnership agreements and chemical control via partner agreements and contracted services at timely intervals throughout the year as prescribed in this Biological Evaluation. Plots should be monitored annually to assess the impact of all control options, especially chemical kill efficacy per herbicide treatments and/or resistance to such applications. Without IVM full control is unlikely.

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Appendix

Appendix 1. Non-native Woody Invasive Species Datasheets:

Appendix 2. Herbicide Treatment Volume Estimates per Extrapolated Data:

Herbicide Treatment Volume Estimates per Extrapolated Cover Data

- Based on extrapolated plot data (Table 1), it was determined that NNWIS dominate 78% of the understory. (4.59 acres)

Herbicide Treatment Volume Estimates per Extrapolated Stem Diameter Class Data:

Based on extrapolated Stem Diameter Class Data (Table 5), 62.9 square feet of stem area will need herbicide stem treatments.

Extrapolation 4.89 acres	0"-.5"	.5"-1"	1"-1.5"	1.5"-2"	>2"	Total 1 to 2" stems
<i>Lonicera japonica</i>	137	0	0	0	0	0
<i>Berberis thunbergii</i>	821	0	0	0	0	0
<i>Forsythia suspensa</i>	1368	0	342	69	0	411
<i>Rosa multiflora</i>	13817	2121	69	0	0	69
<i>Euonymus alatus</i>	15,595	274	69	0	206	275
<i>Lonicera morrowii</i>	15,938	616	0	0	0	0
			480	69	206	755

Table 5: Extrapolated Stem Diameter Class Data per Number of Stems per 4.89 acres NNWIS

Area Calculation for Stem Treatments: $A = \pi r^2$

$$\pi = 3.14$$

$$r = \text{Total stems average size } 1.5'' = 755/12 = 62.91 \text{ SF}$$

$$r^2 = 3.14 \times 62.91 = 197.6 \text{ SF stems requiring Stem Treatment Herbicide Applications}$$

Brand	Active Ingredients	Application	Max. Rate per acre per year
Aqua Neat	53.8% Isopropylamine salt of glyphosate	Foliar	8 quarts per acre per year
Garlon 3A	44.4% Triclopyr Triethylamine salt	Stem	8 quarts per acre per year
Garlon 4	60.45% Triclopyr butoxyethyl ester	Stem	8 quarts per acre per year
Rodeo	53.8% Isopropylamine salt of glyphosate	Foliar	8 quarts per acre per year

Addendum 3: Botanical List of Native Plant Species,

Addendum 4: Pesticide Safety